IIT MADRAS
Indian Institute of Technology Madras

Technology Transfer Office
TTO – IPM Cell

Industrial Consultancy & Sponsored Research (IC&SR)

METHOD TO SYNTHESIZE A RHOMBOHEDRAL (R) PHASE TRANSITION METAL DICHALCOGENIDE (TMD) AND ITS IMPLEMENTATIONS THEREOF

IITM Technology Available for Licensing

Problem Statement

- In recent years, the global interest in two-dimensional (2D) materials, specifically Transitional Metal Dichalcogenides (TMDCs), Molybdenum disulfide (MoS_2) has been extensively studied due to their unique properties
- Existing synthesis methods, predominantly focus on the gaseous precursors, leading to the growth of H-phase MoS_2, with limited ability to selectively grow R-phase material.

Technology Category/ Market

Category – Advanced materials
Applications –Chemicals, Electronics, optoelectronic, and nonlinear photonic devices
Industry – Chemical/ Electrical
Market -The global advanced materials market size was estimated at USD 61.35 billion in 2022 and it is expected to hit around USD 112.7 billion by 2032, poised to grow at a CAGR of 6.27% from 2023 to 2032.

Technology

Discloses a method to synthesize a rhombohedral (R) phase transition metal dichalcogenide (TMD)

Placing a **chalcogenide precursor** in **a first zone** of a reaction chamber, and a transition metal oxide precursor and a substrate in a **second zone** of the reaction chamber

Heating the first zone and second zone of the reaction chamber (810°C to 830°C) and supply carrier gas to first zone and second zone

Providing **a pulsed supply of the carrier gas** to the first zone and the second zone(Flow rate - 0 to 100sccm; Time interval -0 to 5 minutes

Cooling the first zone and second zone of the reaction chamber

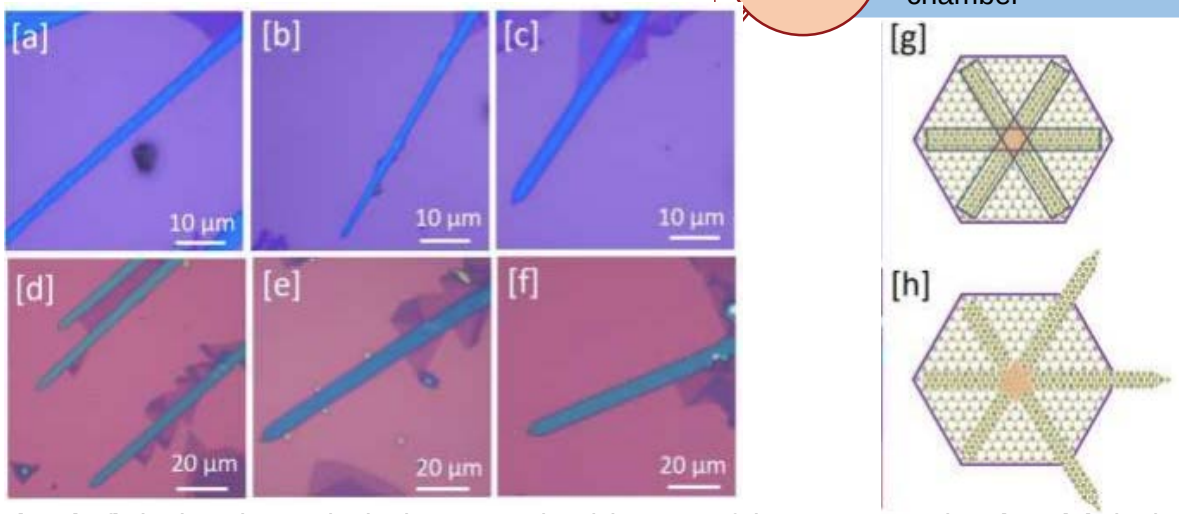

Fig.1(a-f) depicts the Optical Microscopy (OM) images of the MoS_2 swords; **Fig. 1(g)** depicts the schematic evolutions of the MoS2 with a continuous flow of the carrier gas (Argon; Ar); **Fig.1(h)** depicts the schematic evolutions of the MoS2 with pulse flow of the carrier gas (Ar)

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Images

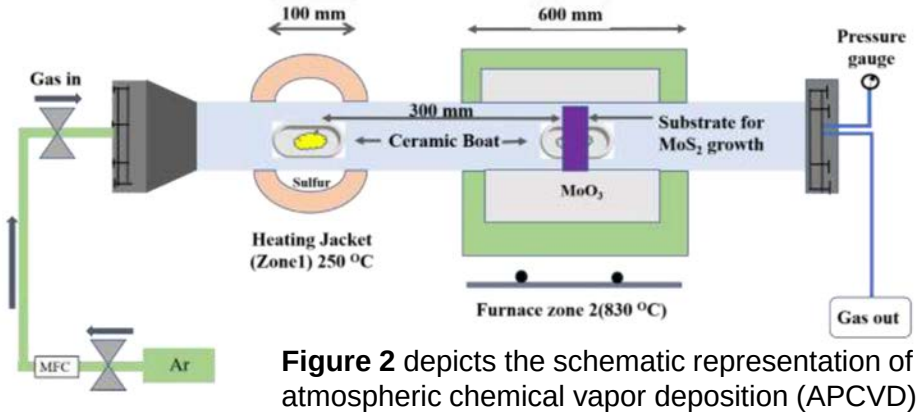

Figure 2 depicts the schematic representation of modified atmospheric chemical vapor deposition (APCVD) growth method

- Chalcogenide precursor is selected from the group consisting of sulphur, selenium, and tellurium.
- The substrate is selected from silicon/silicon dioxide (SiO_2/ Si) substrate and carrier gas is argon.
- Heating in the first zone is done at a temperature in the range of 200°C to 250°C.
- Pulsed supply of the carrier gas allows feeding of more chalcogenide precursor from the first zone to the second zone

Key Features / Value Proposition

Technical Perspective

- Formation of Rhombohedral (R) phase transition metal dichalcogenide (TMD) has a width in the range of 2-3 µm, and thickness in the range of 4-6 nm.
- Provides a method to synthesize a rhombohedral (R) phase transition metal dichalcogenide where *R*-phase MoS_2 has sword like geometry.

User Perspective

- Unlike in conventional methods using gas precursors, the present invention uses two solid precursors, i.e., chalcogenide precursor and a transition metal oxide precursor, that allows better controllability of the gas phase reactions
- Large-area growth of R-phase1(0 to 120 µm) TMDCs, efficient for developing high-performance electronic, optoelectronic, and nonlinear photonic devices
- Devoid of any etching process as the synthesized *R*-phase TMDCs has a well-defined geometry.

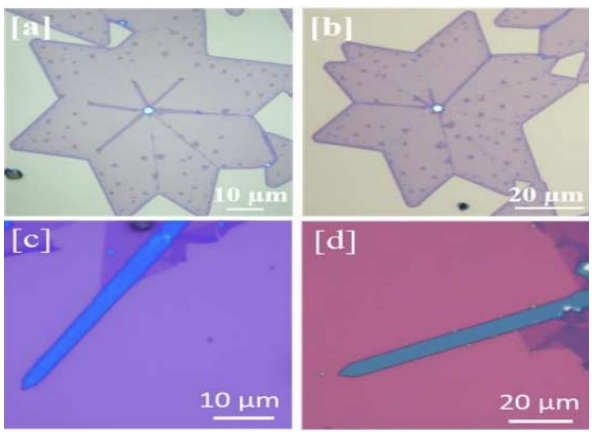

Fig. 3 (a, b) depicts the MoS_2 deposited with a continuous flow of the carrier gas and **Fig. 3(c, d)** depicts the MoS_2 deposited with a pulse flow of the carrier gas

Intellectual Property

- **IITM IDF Ref. 2398**
- **IN436898- Granted**

TRL (Technology Readiness Level)

TRL-4,Technology Validated in Lab

Research Lab

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